MICROWAVE POWER APPLICATION IN PLASMA LIGHT TECHNOLOGY

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Microwave (MW) energy in plasma and light technology is a very interesting and urgent area of application. Plasma lamps and searchlights based on the energy of the MW discharge are not widely used nowadays but, we think, they can become competitive in some ways of light application. Major causes of that are followings: MW with power of hundreds of Watts can ignite luminous plasma very easily; such plasma can be excited without electrodes; absence of any polluting materials in construction of the MW lamp (as compared with other types of gas-discharge lamps); wide radiation pattern of MW lamps (almost 360°); MW lamp spectrum (continuous [1], almost as sunlight); intensity (10 times bigger than LED lamps); total lumens on workspace and coefficient of utilization [2]; in addition, MW plasma light can be easily transformed into other types of energy (for heating, photochemistry, *etc*.). All these advantages make great positive argument to choose this field for research and development.

MW plasma lamps can be used in many different places where people work, live, take a rest, for large area illumination, for example: business and conference halls, rooms with a ceiling height of more than 6 m, for which it is difficult to realize the light in other ways, park and industrial areas, highways, roads, streets, parking lots, advertising and information boards, buildings and different structures, sports ground, stadiums, downhill skiing complexes *etc*. These are just a little list of possible application of MW plasma lamps. Besides one MW lamp can replace from two to four similar lights (based on diodes, metal-halide lamp or sodium lamp of high pressure) due to their directional characteristics and luminous efficiency.

Simulation of microwave plasma, developing of new types of supply voltage schemes and case constructions of the MW lamp *etc*. help to improve the one. Use of sulfur MW lamps has the potential to reduce the total amount of energy required for lighting, which is one of our investigation topics. In addition, optical fibers have been studied as a distribution system for sulfur lamps, but no practical system has ever been marketed yet. Microwave plasma generators, which work on high voltages and frequencies, are needed for such problem solving. In our research work we`ll try to develop a new MW generator of 2.45 GHz based on powerful MW transistors. Currently commercially available microwave high power transistors, parameters of which are given in table 1 [3]. Nevertheless, information on the development of such generators for gas discharge lamps in the literature has not been identified yet. MW plasma light requires power of 500 W; therefore, basing on two or three transistors in the circuit of the power supply will be able to achieve the required power for gas-discharge sulfur plasma lamp. Comparison

with the magnetron microwave generator the use of such transistors scheme allows us to increase MW plasma operating life (approximately 60,000 hours), reduce power consumption (hundreds of watts) of the lamp and improve its mass-dimensional characteristics.

Table 1. Parameters of powerful microwave transistors

Name	Case	Frequency f, MHz	Power P_L, W	Efficiency, %	Power gain GP, dB	Supply voltage V_{DS}, V
BLC2425M8LS300P	SOT1250-1	2400-2500	300	54,5	17,5	32
BLF2425M7L250P	SOT539A	2400-2500	250	51	15	28
BLF2425M7LS250P	SOT539B	2400-2500	250	51	15	28

Microwave plasma lamps for public lighting

The sulfur plasma consists mainly of dimer molecules (S_2), which generate the light by means of molecular emission. Unlike atomic emission, molecular emission spectrum is continuous throughout the visible spectrum.

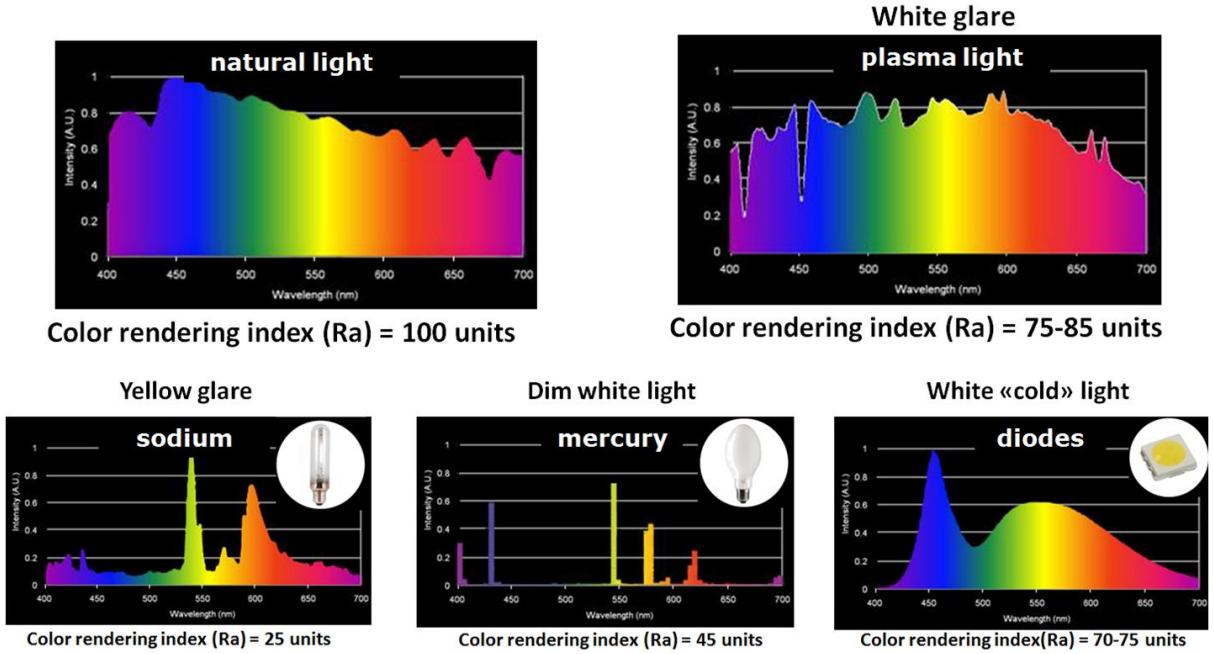

Figure 1. Spectra comparison of different lamps

As much as 73% of the emitted radiation is in the visible spectrum, partially in infrared and less than 1% in ultraviolet frequency ranges. The main practical importance of such lamps is their light, which is similar to sun [3-5]. The correlated color temperature is about 6,000 Kelvin with a color-rendering index (CRI) of 79 (see fig. 1). Luminous efficacy of such lamps can be reached up to 120 lumens per watt!

Microwave plasma lamps for agricultural industry

Apart from facts described above it is very useful the addition of $CaBr_2$ to sulfur radiating medium, which increases the emission at wavelengths near 625 nm, where the quantum efficiency for photosynthesis is close to 1. The increase of red light emission is more efficacious for plant growth than is visible light at shorter wavelengths. It was shown in [6]. Other additives such as lithium

iodide (LiI) and sodium iodide (NaI) can be used to modify the output spectra too. Plants require not only sunlight but also sunrise/sunset imitation, which is very important for agricultural greenhouse industry. MW sulfur vapor lamp fulfils these requirements too. The lamp can be dimmed to 15% of maximum intensity without losses of the light quality.

Conclusions

Waveguide transmission line at frequency of 2.45 GHz and power of 500 W was simulated. On the basis of the simulation, using magnetron 2M214 as generator of MW power, MW plasma generator is built. The new MW generator of 2.45 GHz based on powerful MW transistors is developed and now it is on building. Due to such adoption MW plasma operating life will be increased, power consumption of the lamp is reduced and its mass-dimensional characteristics are improved. Due to this device we`ll try to determine the expediency of practical application of MW sulfur vapor lamp in agricultural and public lighting.

References

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Abstract

New trend of lighting technology – 2.45 GHz microwave plasma sulfur vapor lamps, which provide a continuous emission spectrum (similar to sunlight) and are environmentally friendly, was considered. Field of development in trend of microwave power system and microwave tubes construction is determined.

Keywords: microwave gas discharge sulfur vapor lamp, microwave plasma.

Анотація

Розглянуто новий напрямок світлотехніки – НВЧ плазмові світильники на прах сірки, які забезпечують безперервний спектр світіння (близький до сонячного) і є екологічно безпечними. Визначено напрями розробок у напрямку конструювання НВЧ ламп і системи НВЧ живлення.

Ключові слова: НВЧ газорозрядний світильник на парах сірки, НВЧ плазма.

Аннотация

Рассмотрено новое направление светотехники – СВЧ плазменные светильники на прах серы, которые обеспечивают непрерывный спектр свечения (подобный солнечному) и являются экологически безопасными. Определены направления разработок в направлении конструирования СВЧ ламп и системы СВЧ питания.

Ключевые слова: СВЧ газоразрядный светильник на парах серы, СВЧ плазма.